

Insects Attacking Ferns in the Hawaiian Islands.

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In a recent paper by Dr. Charles T. Brues on "The Selection of Food-plants by Insects, With Special Reference to Lepidopterous Larvae,"* he says, "The term phytophagous with reference to insects is commonly employed in a considerably restricted and rather inaccurate sense, including only those species that feed upon the higher plants, meaning by these the ferns and flowering plants. Only an extremely small, almost negligible, proportion subsist upon ferns, so that from a practical standpoint, we would include only those feeding upon the Spermatophytes."

It is to be presumed that Dr. Brues has in mind conditions of his region, the Eastern United States, when he says an almost negligible proportion of insects subsist upon ferns. Here in the Hawaiian Islands a considerable number of insects subsist exclusively upon ferns, besides quite a number of others which are more or less associated with them.

During the seventeen years that the writer has been engaged in economic entomology in the Hawaiian Islands, the study of the habits, host-plants, life histories, parasitic relations, etc., of the endemic insects have received considerable attention as well as have the introduced insects which were of economic importance. In becoming familiar with the endemic insect fauna of the Hawaiian Islands, one soon learns that the different species are largely attached to particular trees or plants, and conversely that each species of tree or plant has its own peculiar insect fauna—one or more species of insects which feed upon it exclusively. Following out this phase of the insect relations to the plants, much attention has been given to the study of the insect faunas of some of the more important native trees which seemed to have a larger insect fauna than many of the other species.

Along these lines, the native ferns in the Hawaiian Islands have come in for their share of similar consideration. The

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* American Naturalist, LIV:313, 1920.

Hawaiian Islands are rather rich in ferns, from very small moss-like species to large tree-ferns, about 130 species in all, and there is found to be quite an extensive insect fauna peculiar to these ferns. Perhaps not every species of fern is attacked by insects, but there are quite a number which have one or more species of insects peculiar to them. Information on these insects accumulates slowly, and is as yet far from complete, but the following are known at present:

LEPIDOPTERA.

Eriopygodes euclidias (Meyrick). [Caradrinidae.]

This moth is very abundant in the forests where ferns abound. Its caterpillar is the cutworm type, though it remains on its food-plant in daytime instead of hiding under rubbish or in the soil. They feed on many kinds of ferns, and apparently only on ferns. The caterpillar varies from nearly plain green to almost black.

Scotorythra rara (Butler). [Selidosemidae.]

Caterpillars of this moth are very polyphagous, mostly feeding on trees, but they have also been found feeding on ferns. They occur on all the islands of the group.

Batrachedra sophroniella Walsingham. [Hyponomeutidae.]

The larvae of this moth feed on the sporangia of *Aspidium cyatheoides*, protected by a web. When there are no more sporangia, they feed on the undersurface of the frond, eating away the parenchyma and leaving the upper epidermis which then shows as dead spots. Pupation takes place within a cocoon alongside of the midrib of a pinna. This moth is known on Oahu, Maui, and Hawaii. I have taken it at Pauoa, Mt. Tantalus, Pacific Heights Ridge, Hillebrand's Glen, Halawa, and Waiawa on Oahu; Keanae, Maui; Waimea, Hawaii.

Batrachedra lomentella Walsingham. [Hyponomeutidae.]

This species has similar habits, but the identity of the fern to which it is attached cannot be stated with certainty. The moth is known on Oahu and Hawaii. I reared it from unidentified ferns in Hakalau Gulch, Hawaii; and Palolo, Oahu.

Batrachedra bedelliella Walsingham. [Hyponomeutidae.]

The larvae of this tiny moth feed among the sporangia of

the birdnest fern, *Asplenium nidus*. I have reared them from Palolo, Oahu, and Hakalau, Hawaii. They no doubt occur on all the islands where this fern does. In the Fauna Hawaiiensis the species is recorded from Maui and Molokai. I have found larvae feeding among the sporangia of *Elaphoglossum reticulatum* in Palolo Valley, Oahu, which I failed to rear. It may be the same species, and yet it might be still another species of the same genus.

Batrachedra syrraphella Walsingham. [Hyponomeutidae.]

The larvae of this species feed on the sporangia of *Dryopteris parasitica*. They hide within a white silken tunnel produced wherever they are feeding. I have reared it from Palolo Valley and from Waianae, Oahu; and have collected it besides at Niu, Wailupe, Kaumuahona, Hillebrand's Glen, Waiahole and Kaala, Oahu. In the Fauna Hawaiiensis it is also recorded from Kona and Kilauea, Hawaii.

Batrachedra sp.

I found fronds of *Pteris irregularis* on Mt. Tantalus, Oahu, very much mined by a small larva which was taken to be of a species of *Batrachedra*, but no adults were reared to prove their identity.

Batrachedra spp.

There are four other native species of this genus whose habits are not known, but it is likely that they may be found to be attached to some of the ferns.

At several places in the mountains of Oahu, *Polypodium spectrum* fronds have been found mined by a lepidopterous larva larger than the preceding. None have been reared, however, so that the species of moth is yet unknown.

Euhypomocoma ekaha (Swezey). [Hyponomeutidae.]

The larvae of this moth feed singly on the underside of the fronds of *Asplenium nidus*. They eat off the parenchyma, leaving the upper epidermis which shows as dead patches. While feeding, the larva is protected by a covering of silk and frass, making a sort of covered way connected with a burrow in the midrib where the larva stays when not feeding. This covered way is shifted as the eaten-off area enlarges in size. This moth occurs wherever this species of fern is found in the

numerous mountain valleys of Oahu, but has not yet been found on the other islands.

Euhypsmocoma trivitella Swezey. [Hyponomeutidae.]

The larvae of this moth are miners in the simple sterile fronds of *Elaphoglossum reticulatum*, and have been found only on the east side of the mountains of Kauai.

Hypsmocoma spp.

Several undetermined species of these tiny moths are associated with ferns. The larvae live in cases, and several kinds of these cases have been found on fern fronds or in dead, decaying frond-stalks of tree-ferns. Possibly they are not particularly attached to the ferns as host-plants. This remains to be determined.

COLEOPTERA.

Heteramphus filicum Perkins. [Cossonidae.]

This weevil is found in rotting tree-fern trunks or stumps on Oahu. As yet it is not known to have any other habitat, and is considered a fern insect.

Heteramphus wollastoni Sharp.

Heteramphus foveatus Sharp.

These two closely related species are also occasionally found in similar situations as *filicum* on Oahu, but their usual food-plant is *Astelia veratroides*.

Heteramphus swezeyi Perkins. [Cossonidae.]

The larvae of this species are miners in the sterile fronds of *Elaphoglossum reticulatum*, *micradenium*, *gorgonum* and *squamosum*. They pupate and develop to the adult beetle within the mine. The species has been observed chiefly in Palolo Valley, Oahu, but has been taken also at Punaluu towards the opposite end of the same mountain range, and its mines have been observed at Wahiawa about the middle of the range; hence, it apparently occurs throughout the range. It has not yet been found on the other Islands.

Oodemas brunneum Perkins. [Cossonidae.]

This weevil occurs in dead frond-stalks of *Pteris* on Molokai.

Oodemas aenescens Bohman. [Cossonidae.]

This species occurs in dead frond-stalks of *Cibotium* spp.

on Oahu and Lanai. It is not confined to ferns, however, for it also occurs in dead branches of many kinds of trees and shrubs.

Pentarthrum prolixum Sharp. [Cossonidae.]

This elongate weevil is found, often abundantly, in the dead frond-stalks of two or three species of *Cibotium*, tree-ferns. It does not occur on anything else. It is common on all the Islands.

Dryophthorus pusillus Sharp. [Cossonidae.]

This weevil occurs on Oahu, and inhabits decaying tree-ferns, *Cibotium* spp.

Dryophthorus modestus Sharp. [Cossonidae.]

This species occurs on Oahu, Maui, and Hawaii, and is rarely found in similar places to the preceding.

Dryophthorus insignis Sharp. [Cossonidae.]

This species occurs on all the Islands and is more often found on tree-ferns, inhabiting the dead frond-stalks. The species of the genus *Dryophthorus* usually feed in rotten wood, and it is likely that some of the other species may also be found in decaying fern-stems.

Pseudolus longulus (Boh.). [Cossonidae.]

The larvae of this weevil feed in the dead frond-stalks of *Cibotium chamissoi*. They also feed in dead bamboo and other dead or rotten wood. It occurs on all the Islands.

Proterhinus longulus Sharp. [Proterhinidae.]

This representative of the endemic family Proterhinidae is found on tree-ferns (*Cibotium chamissoi*, *C. menziesii*). The larvae feed in the dead frond-stalks. The species occurs only in the forests of Oahu.

Proterhinus pteridis Perkins. [Proterhinidae.]

This species occurs on Molokai, in the leaf-stalks of a species of *Pteris*.

Proterhinus sharpi Perkins. [Proterhinidae.]

This species occurs on Haleakala, Maui, on a non-arboreal fern. A number of other species of *Proterhinus* are commonly

swept from ferns, and it is likely that they will be found to be attached to them when their habits are fully studied.

Holcobius hawaiiensis Perkins. [Ptinidae.]

This beetle has been taken at base of tree-ferns.

Nesapterus monticola (Sharp). [Nitidulidae.]

I found two specimens of this beetle in the dead frond-stalk of *Cibotium menziesii* in Palolo Valley. Otherwise the habits of the species are not known.

DIPTERA.

Drosophila sp. [Drosophilidae.]

An undescribed species of this genus has been reared from living frond-stalks of *Sadleria cyatheoides* at Niu, Oahu, and at Kilauea, Hawaii. The larvae are found in the very young fronds. They are very elongate, and tunnel up and down in the stem. There is hardly a frond to be found on any plant of this fern that has not several of these tunnels, but the fern does not seem to be seriously injured by them.

Agromyza sp. [Agromyzidae.]

An undescribed species of this genus is a miner in the fronds of *Marattia douglassi*. The mines are often very abundant, but very few adults have been reared. It occurs on Oahu, and possibly on the other Islands wherever the fern occurs.

HOMOPTERA.

Oliarus kaonohi Kirkaldy and *O. montivagus* Kirkaldy of the Cixiidae have been reared from nymphs occurring in decaying frond bases and in the fibrous matter of tree-fern stems, and in the dead frond-stalks. It is likely that several of the other species of this genus are also attached to ferns, for many of them are taken by sweeping on ferns. It is probable that the near-related *Iolania perkinsi* Kirkaldy may be found to breed similarly, for the adults are commonly collected from ferns.

Ilburnia ipomoeicola Kirkaldy. [Delphacidae.]

This small leafhopper is associated with *Sadleria cyatheoides*. It oviposits very abundantly in the young tender frond-stalks. It has been reported on *Cibotium*, and also occurs on

a few other plants. It is known on Kauai, Oahu, and Hawaii.

Ilburnia amamau Muir. [Delphacidae.]

This species occurs on *Sadleria cyatheoides* on Haleakala, Maui.

Ilburnia nephrolepidis (Kirkaldy). [Delphacidae.]

This species occurs on *Nephrolepis exaltata*. It has been collected at Maunawili, Oahu; Iao Valley, Maui; Oookala and Kilauea, Hawaii.

Nesorestias filicicola Kirkaldy. [Delphacidae.]

Has been collected from *Elaphoglossum gorgonum*, and possibly other ferns. Palolo, Pacific Heights and Tantalus, Oahu.

Nesorestias nimbata (Kirkaldy). [Delphacidae.]

Has been collected on *Phegopteris* sp. and may occur on other ferns. Collected at Kaumuahona, Waiawa, Waiahole and Punaluu, Oahu.

Nothorestias badia Muir. [Delphacidae.]

Collected on undetermined ferns at Kulioouou, Oahu.

Nothorestias swezeyi Muir. [Delphacidae.]

Collected on *Aspidium* sp. at Makaha, Oahu, 1500 feet elevation.

There are likely other species of Delphacidae yet to be discovered that are attached to some of the different ferns.

Nesophryne filicicola Kirkaldy. [Tetigoniidae.]

Nesophryne microlepieae Kirkaldy.

These two species were recorded from *Microlepiea strigosa*, Kalihiwai, Kauai.

Idiopterus nephrolepidis Davis. [Aphididae.]

This aphidid is often found on *Elaphoglossum reticulatum* and some other native ferns, and by some is considered a native insect.

ORTHOPTERA.

Paratrigonidium filicum Perkins. [Trigonididae.]

This small cricket was found by Perkins at Olaa, Hawaii (two thousand feet), "in dense forest, frequenting a tall soft fern, which covers the ground beneath the trees."

Paratrigonidium viridescens Perkins. [Trigonididae.]

This cricket was found in the same locality as the preced-

ing species, but it "lives among a beautiful creeping fern, which clothes the tree-trunks in wet forests."

Banza spp. [Locustidae.]

Adults and young of several species are often found on ferns.

PREDATORS.

Several species of native Carabidae are always to be found in dead or hollow frond-stalks and decaying tree-fern stems, where they are in search of prey. An occasional predacious bug, and earwigs are also found in these places, as well as the peculiar crickets *Prognathogryllus* and allies.

None of the native insects occurring on ferns in the Hawaiian Islands are particularly injurious to the ferns which they infest. There are parasites working on them, which largely accounts for their control. There is no telling, however, but what they might prove serious pests, if by any chance some of them became introduced into other countries, just as the Australian fern-weevil has done in Hawaii.

Besides the endemic insects, a few others are sometimes found on ferns in the forests of Hawaii; as, for example, the wax scale (*Ceroplastes rubens* Maskell) on *Elaphoglossum reticulatum* and other ferns, and some of the other introduced scales on different ferns, but none of them are of any consequence.

Syagrius fulvitaris Pascoe. [Molytinae.]

This is known as the Australian fern weevil,* which first appeared in fern-houses in Honolulu, and then a little later (about 1904) became established in the open and spread to a considerable extent in the mountains in the immediate vicinity of Honolulu, practically exterminating one of the most abundant ferns (*Sadleria cyatheoides*) and a species of *Asplenium*, but not harming the tree-ferns (*Cibotium* spp.) nor other ferns. The chief injury is done by the feeding of the larvae in the frond-stalks, killing them prematurely, and eventually causing

* *Ischiogonus syagrii* Fullaway, a parasite on the fern weevil, was discovered in Australia by C. E. Pemberton in April, 1921, and introduced to Hawaii. It became established quickly, but it yet remains to be demonstrated whether it will become as effective here as in Australia in controlling the pest.

the death of the whole plant. In 1909, it was found to have become established in a fern-house in Hilo on the Island of Hawaii. Attempts were made to eradicate it there, but later on it was found generally spread throughout the town, and by 1920 had extended its spread to some distance outside. A considerable colony was found at a distance of twenty-nine miles and at an elevation of nearly four thousand feet, near the volcano Kilauea, where there are extensive tree-fern forests, in places chiefly composed of *Sadleria*, which were thus threatened with destruction as they had been in the mountains near Honolulu. Strenuous measures were employed by the Territorial Board of Agriculture to eradicate the weevil in that place, with as good success as has ever been attained in the destruction of an insect pest that has once become thoroughly established.